

# Contents

<b>List of Figures</b> .....	XIII
<b>List of Tables</b> .....	XVII
<b>Acronyms</b> .....	XXI
<b>List of Symbols</b> .....	XXIII
<b>1 Introduction</b> .....	1
1.1 Motivation .....	1
1.2 Objectives .....	4
1.3 Structure of this work .....	6
<b>2 Fundamentals</b> .....	11
2.1 Topical placement .....	11
2.2 Literature review on disassembly planning .....	17
2.3 A first disassembly-to-order planning model .....	29
<b>3 Complete disassembly planning</b> .....	33
3.1 Basic model .....	33
3.1.1 Aspects to include in modelling complete disassembly .....	33
3.1.2 Model formulation .....	40
3.1.3 Numerical example .....	46
3.2 Linear price-quantity dependencies .....	52
3.2.1 Applicable quantity and price dependencies .....	52
3.2.2 Proof of concavity for the objective function .....	55
3.2.3 Numerical example .....	57

3.3	Piecewise linear price-quantity dependencies . . . . .	58
3.3.1	Objective function and its properties . . . . .	58
3.3.2	Model formulation . . . . .	62
3.3.3	Solution finding . . . . .	64
3.3.4	Numerical example . . . . .	97
3.3.5	Summary . . . . .	102
3.4	Rolling horizon disassembly planning . . . . .	103
3.4.1	Motivation . . . . .	103
3.4.2	Problem description . . . . .	106
3.4.3	Planning considerations . . . . .	115
3.4.4	Numerical example . . . . .	129
3.5	Concluding remarks . . . . .	151
<b>4</b>	<b>Flexible disassembly planning . . . . .</b>	<b>153</b>
4.1	Introduction . . . . .	153
4.2	Flexible disassembly planning model . . . . .	154
4.2.1	Disassembly sequencing . . . . .	154
4.2.2	Model extension . . . . .	165
4.2.3	Model formulation . . . . .	204
4.2.4	Numerical example . . . . .	213
4.3	Benefit of flexible disassembly planning . . . . .	223
4.3.1	Flexible vs. complete disassembly planning . . . . .	223
4.3.2	Flexible vs. incomplete two-stage disassembly planning . . . . .	225
4.3.3	Optimal flexible disassembly planning with minimal number of sequences . . . . .	232
4.4	Determining concrete disassembly path . . . . .	239
4.4.1	Determining disassembly state quantities . . . . .	239
4.4.2	Assigning cores to selected states and recommended usage . . . . .	252
4.5	Discussion of alternative solution methods . . . . .	265
4.5.1	Using the continuous solution . . . . .	265
4.5.2	Fixed solution time . . . . .	272
4.5.3	Reducing the disassembly state graph . . . . .	274
4.5.4	Alternative condition constraints . . . . .	280
4.6	Concluding remarks . . . . .	289
<b>5</b>	<b>Résumé . . . . .</b>	<b>293</b>
<b>A</b>	<b>Appendix to Chapter 2 . . . . .</b>	<b>299</b>

<b>B</b>	<b>Appendix to Chapter 3</b> . . . . .	301
B.1	Basic model with destructive and non-destructive disassembly cost differentiation . . . . .	301
B.2	Compact basic model formulation . . . . .	305
B.3	Order of section optima . . . . .	308
B.4	Proof of objective dominance . . . . .	310
B.5	Algorithm for solving QLP with partially defined objective functions . . . . .	313
B.6	Proof of symmetry of quadratic function . . . . .	314
B.7	Proof of maximal underrun of purity level . . . . .	315
B.8	Compact dynamic model . . . . .	318
B.9	Optimal values $X_{tci}^I$ , $X_{tcir}^R$ , and $X_{tcid}^D$ . . . . .	322
B.10	Optimal values $X_{tci}^I$ , $X_{tcir}^R$ , and $X_{tcid}^D$ (20 periods) . . . . .	323
B.11	Potential for profit increasing . . . . .	327
<b>C</b>	<b>Appendix to Chapter 4</b> . . . . .	331
C.1	Linear and star core configuration . . . . .	331
C.2	Number of edges of core graph . . . . .	334
C.3	Compact flexible model formulation . . . . .	336
C.4	Data excerpt of core, distribution, recycling, and disposal graph . . . . .	345
C.5	Optimal solutions of state limited flexible planning . . . . .	352
C.6	Module and state definition for the two examples . . . . .	356
C.7	State quantity determination for example one . . . . .	359
C.8	Incoming units and their assignment for cores 2 and 3 . . . . .	361
C.9	Incoming units and their assignment with LP for cores 2 and 3 . . . . .	370
	<b>References</b> . . . . .	375

Advanced Disassembly Planning  
Flexible, Price-Quantity Dependent, and Multi-Period  
Planning Approaches

Ullerich, C.

2014, XXXV, 391 p. 67 illus., Softcover

ISBN: 978-3-658-03117-6